# Digital Elevation Model of the Upper Gulf and East Texas Coast: Procedures, Data Sources, and Analysis

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# Summary

This report briefly describes the creation of a collection of tiled Digital Elevation Models (DEMs) developed for the Upper Texas Coast during Fall 2017 by the National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI; Fig. 1). This work was funded by the National Weather Service (NWS) under the auspices of the COASTAL Act Project to support improvements in NOAA's storm surge modeling capabilities.

Forty-nine tiled DEMs were created: 28 at a spatial resolution of 1/9 arc-seconds (~ 3 m) and 21 at 1/3 arc-seconds. The DEMs represent the best available coastal elevation data available at the time of their creation. Only the 1/9 arc-second DEM tiles integrate both topography and bathymetry. The 1/3 arc-second DEM tiles represent bathymetry only. The DEM tiles are horizontally referenced to the North American Datum of 1983 (NAD83) and vertically referenced to the North American Vertical Datum of 1988 (NAVD88).

The utilization of a tiling scheme in developing the DEMs is intended to improve data management during source data processing as well as facilitate targeted DEM updates as new coastal elevation data is acquired.

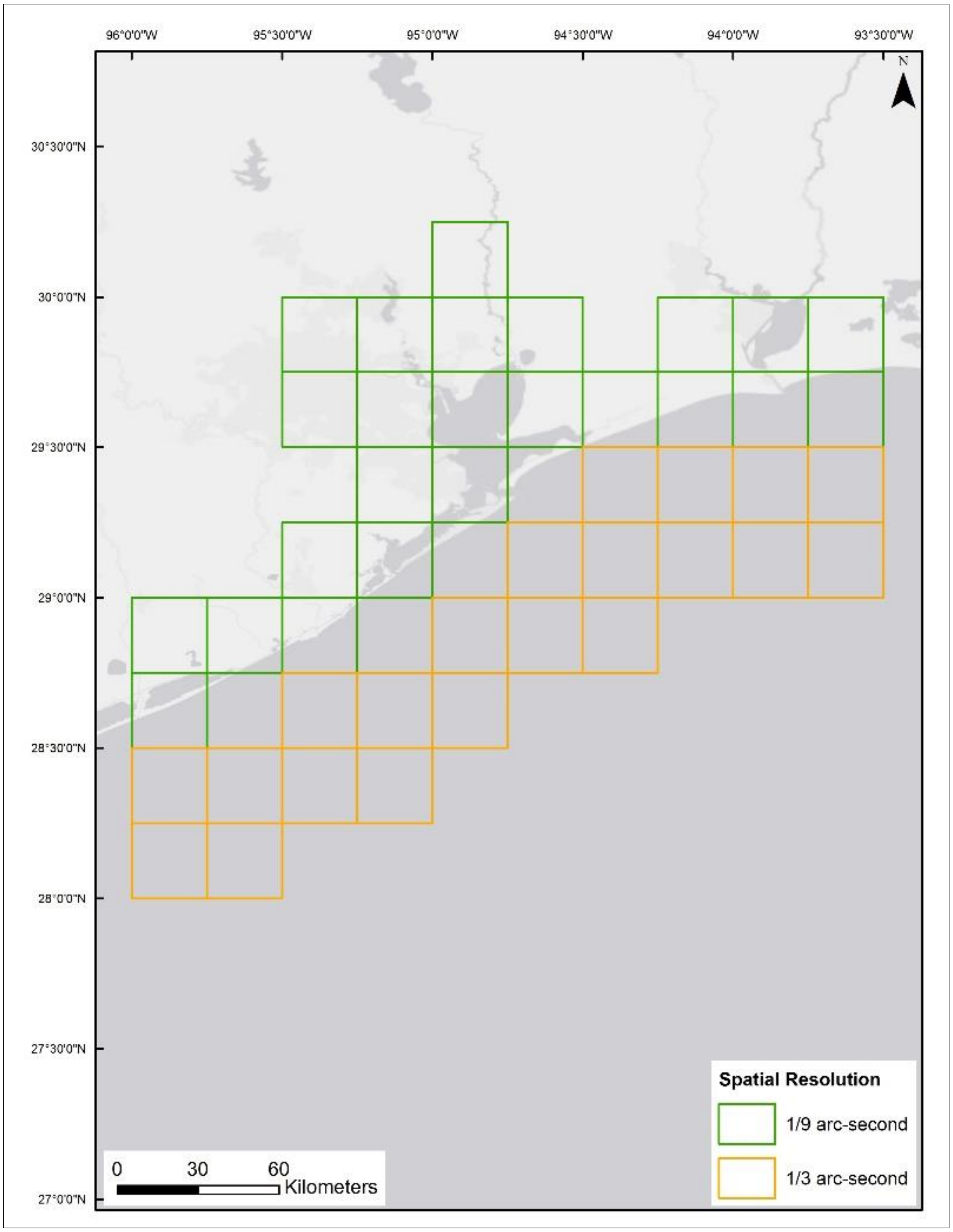


**Figure 1.** Spatial extent of the 2017 NOAA NCEI Texas DEM Tiles.

# Data Sources and Processing

Original source topographic and bathymetric data were collected by many different federal and state agencies, including NOAA, the United States Geological Survey (USGS), United States Army Corps of Engineers (USACE) and Texas Natural Resources Information System (TNRIS). Source data were obtained in a variety of different formats and referenced to disparate horizontal and vertical datums (Table 1).

**Table 1: Data sources used in DEM development.**

| *Source* | *Date* | *Data Type* | *Horizontal Datum* | *Vertical Datum* |
|---|---|---|---|---|
| NOAA National Geodetic Survey | 2014 | Topographic-bathymetric lidar | NAD 83 | NAVD 88 |
| NOAA National Ocean Service | 1933 to 2015 | Hydrographic survey soundings and bathymetric attributed grids (BAGs, see Appendix A) | NAD 83 | MLLW |
| USGS | 2012 | Gridded bathymetric lidar: Data Series 885 and 887 | NAD 83 UTM Zone 18 | NAVD 88 |
| USGS | 2011 to 2013 | Gridded Interferometric sonar bathymetry: Data Series 937 | NAD 83 | NAVD 88 |
| USGS | 2008 to 2015 | Topographic lidar | NAD 83 | NAVD 88 |
| U.S. Army Corps of Engineers (USACE) | 2015 to 2017 | Bathymetric soundings | | |

All source data were converted to common horizontal and vertical reference frames using a combination of Geospatial Data Abstract Libraries (GDAL) utilities and the NOAA VDatum software utility, depending on the dataset in question. The vertical datum of bathymetric datasets referenced to Mean Lower Low Water (MLLW) were converted to the North American Datum of 1988 (NAVD88) for consistency with topographic data already referenced to NAVD88. No conversion occurred among topographic datasets referenced to different realizations of NAVD88 (i.e. defined by different geoid models). Various locations in the study area were examined using VDatum to determine if such a conversion was warranted. The results indicated this to be unnecessary, as the magnitude of these differences is on the order of centimeters, and assumed to be within the measurement uncertainty associated with the lidar data.

All data were converted to a common data format (ASCII xyz) in preparation for gridding. If a dataset was obtained in a raster format, it was resampled using a bilinear resampling algorithm to match the spatial resolution and pixel registration of the affected tile, then converted to ASCII xyz using GDAL. All data was reviewed and evaluated for internal and external consistency with adjacent data. Anomalies in were removed through visual inspection and automated filtering.

MB-System's 'mb-grid' utility was used for all gridding processes. A tensioned thin-plate spline algorithm was used to interpolate depth values in pixels within the DEM extent that were unconstrained by elevation measurements. Constrained pixels were assigned a final elevation value based on the Gaussian weighted average of the input source elevation measurements.

An initial bathymetric surface was created using the source bathymetry (See Carignan et al., 2011 for a detailed description of the process). The bathymetric surface was initially gridded at a spatial resolution of 1/3 arc-seconds, then resampled to the target resolution of 1/9 arc-seconds. Given the disparate nature of the source bathymetric data, a low-pass median filter (5x5 kernel) was applied to each bathymetric surface in order to further minimize (i.e. smooth) offsets among adjacent datasets. The smoothed bathymetric surface was converted to ASCII xyz and included as an input data source along with cleaned topography into 'mb-grid' to create the final integrated elevation surface. In cases

Final DEM tiles were qualitatively evaluated to identify anomalous data points, as well as compared with imagery and NOAA Raster Nautical Charts. If necessary, persistent anomalies were cleaned from the input source data and the DEM tile was re-generated using the previously described processes. No quantitative analysis was performed to assess the accuracy of the DEMs, although this continues to be an area of active research at NCEI (see Amante and Eakins, 2016).

# Reference

Amante, C.J. and Eakins, B.W., 2016. Accuracy of interpolated bathymetry in digital elevation models. In: Brock, J.C., Gesch, D.B., Parrish, C.E., Rogers, J.N., and Wright, C.W. (eds.), Advances in Topobathymetric Mapping, Models and Applications. Journal of Coastal Research, Special Issue, No. 76, pp.122-133.

Carignan, K.S.; Taylor, L.A.; Eakins, B.W.; Caldwell, R.J; Friday, D.Z.; Grothe, P.R. and Lim, E., 2011. Digital Elevation Models of Central California and San Francisco Bay: Procedures, Data Sources and Analysis. NOAA Technical Memorandum NESDIS NGDC-52, 49p.

# Appendix A

NOAA NOS BAG Survey List: UF00561, H11399, H11916, H12036, H12568, H12569, H12570, H12571, H12572, H12586, H12587, H12589, H12590, H12596, H12597, H12598, H12599, H12605, H12608, H12609, H12610, H12627, H12628, H12687